800mA Low Dropout Voltage Regulator

FEATURES

- Guaranteed 0.8A Output Current
- Guaranteed 1A Peak Current
- Three Terminal Adjustable or Fixed 1.5V, 1.8V, 2.5V, 2.85V, 3.0V and 3.3V
- Low Quiescent Current
- Low Dropout Voltage of 1.1V at 0.8A
- 0.1% Line and 0.2% Load Regulation
- Voltage Temperature Stability 0.05%
- Stable with 2.2uF Ceramic Capacitor
- Overcurrent and Thermal Protection
- Available Packages: SOT-223, TO-252, TO-220, and TO-263

APPLICATIONS

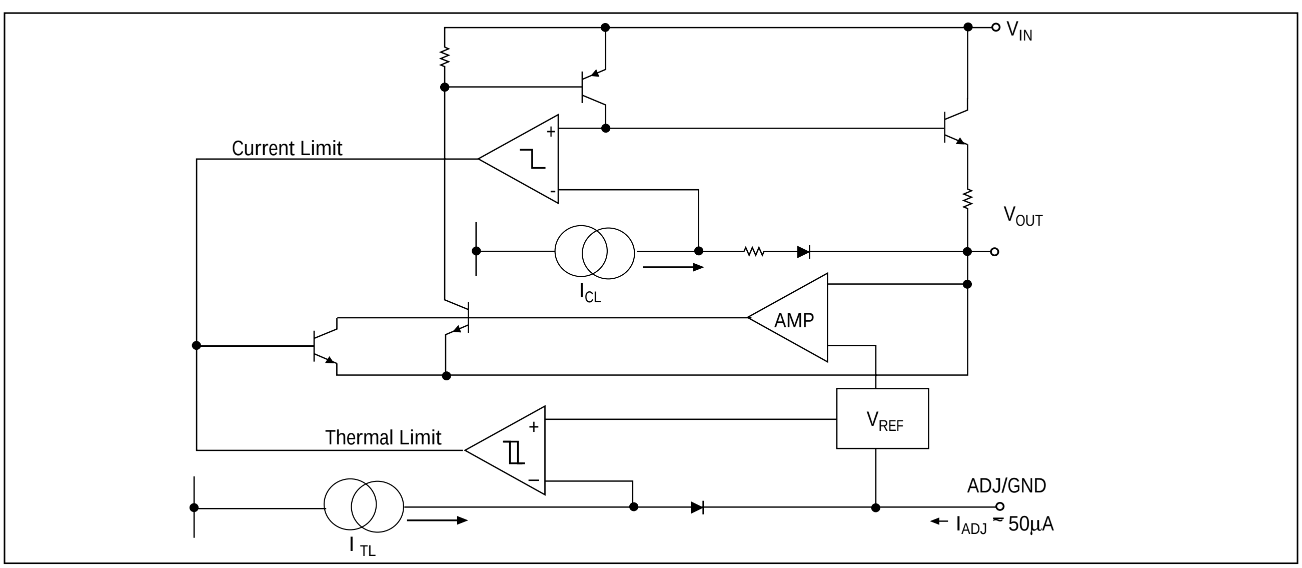
- Desktop PC's Servers
- SCSI-II Active Terminator
- Portable/ Palm Top / Notebook Computers
- Cordless Phones
- Battery Chargers
- Disk Drives
- Portable Consumer Equipment
- Portable Instrumentation
- SMPS Post-Regulator

DESCRIPTION

The SPX1117 is a low power positive-voltage regulator designed to satisfy moderate power requirements with a cost effective, small footprint solution. This device is an excellent choice for use in battery-powered applications and portable computers. The SPX1117 features very low quiescent current and a low dropout voltage of 1.1V at a full load. As output current decreases, quiescent current flows into the load, increasing efficiency. SPX1117 is available in adjustable or fixed 1.5V, 1.8V, 2.5V, 2.85V, 3.0V and 3.3V output voltages.

The SPX1117 is offered in several 3-pin surface mount packages: SOT-223, TO-252, TO-220 and TO-263. An output capacitor of 10µF provides unconditionally stability while a smaller 2.2µF capacitor is sufficient for most applications.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Power Dissipation......................................Internally Limited
Lead Temperature (soldering, 5 seconds) ....260°C
Storage Temperature Range.......................-65°C to +150°C
Operating Junction Temperature Range.....-40°C to +125°C
Input Supply Voltage .... +20V
ESD Rating...2kV min

ELECTRICAL CHARACTERISTICS

at $V_{IN}=V_{OUT} + 1.5V$, $T_A = 25°C$, $C_{IN} = C_{OUT} = 10\mu F$, unless otherwise specified. The Boldface applies over the full operating temperature range.

PARAMETER	CONDITIONS	TYP	MIN	MAX	UNITS
1.5V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =3.0V 0mA ≤ I_{OUT} ≤ 800mA, 2.9V ≤ V_{IN} ≤ 10V	1.485 **1.470**	1.500	1.515 **1.530**	V
1.8V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =3.3V 0mA ≤ I_{OUT} ≤ 800mA, 3.2V ≤ V_{IN} ≤ 10V	1.782 **1.764**	1.800	1.818 **1.836**	V
2.5V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =4.85V 0mA ≤ I_{OUT} ≤ 800mA, 4.25V ≤ V_{IN} ≤ 10V	2.475 **2.450**	2.500	2.525 **2.550**	V
2.85V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =4.85V 0mA ≤ I_{OUT} ≤ 800mA, 4.25V ≤ V_{IN} ≤ 10V	2.821 **2.793**	2.850	2.878 **2.907**	V
3.00V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =4.85V 0mA ≤ I_{OUT} ≤ 800mA, 4.75V ≤ V_{IN} ≤ 10V	2.970 **2.940**	3.000	3.030 **3.060**	V
3.30V Version					
Output Voltage	I_{OUT} = 10mA, V_{IN} =5.00V 0mA ≤ I_{OUT} ≤ 800mA, 4.75V ≤ V_{IN} ≤ 10V	3.267 **3.234**	3.300	3.333 **3.366**	V
All Voltage Options					
Reference Voltage	I_{OUT}=10mA, (V_{IN} - V_{OUT})= 2V 0mA≤I_{OUT}≤ 800mA, 1.4V≤(V_{IN}-V_{OUT})≤ 10V	1.238 **1.225**	1.250	1.262 **1.270**	V
Output Voltage Temperature Stability	Note 1			**0.05**	%
Line Regulation	4.50V≤V_{IN}≤ 12V,V_{OUT}=3.0V,I_{OUT}=0mA 4.80V≤V_{IN}≤ 12V,V_{OUT}=3.3V,I_{OUT}=0mA 6.50V≤V_{IN}≤ 15V,V_{OUT}=5.0V,I_{OUT}=0mA		3 3 3	7 7 10	mV
Load Regulation	0mA≤I_{OUT}≤ 800mA,V_{IN}=4.5V,V_{OUT}=3.0V 0mA≤I_{OUT}≤ 800mA,V_{IN}=4.8V,V_{OUT}=3.3V 0mA≤I_{OUT}≤ 800mA,V_{IN}=6.5V,V_{OUT}=5.0V		6 6 6	12 12 15	mV
Dropout Voltage (Note 2)	I_{OUT}=100mA I_{OUT}=500mA I_{OUT}=800mA		1.00 1.05 1.10	1.10 1.15 1.20	V
Quiescent Current	4.25V≤V_{IN}≤ 6.5V		5	10	mA
Adjust Pin Current			50	**120**	µA
Current Limit	(V_{IN}-V_{OUT})=5V	1.0	1.5	2.0	A

ELECTRICAL CHARACTERISTICS*(cont.)*

at V_{IN}=V_{OUT} + 1.5V, T_A = 25°C, C_{IN} = C_{OUT} = 10µF, unless otherwise specified. The Boldface applies over the full operating temperature range.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Thermal Regulation	25°C, 30mS pulse		0.01	0.1	%/W
Ripple Rejection	f_{RIPPLE}=120Hz, (V_{IN}-V_{OUT})=3V, V_{RIPPLE}=1V_{PP}	60	75		dB
Long Term Stability	125°C, 1000Hrs		0.03		%
RMS Output Noise	% of V_{OUT}, 10Hz≥f≥10kHz		0.003		%
Thermal Resistance	TO-220 Junction to Case, at Tab TO-220 Junction to Ambient TO-263Junction to Case, at Tab TO-263 Junction to Ambient TO-252 Junction to Case, at Tab TO-252 Junction to Ambient SOT-223 Junction to Case, at Tab SOT-223 Junction to Ambient		3 60 3 60 6 126 15 156		°C/W

NOTES:

Note 1: Output temperature coefficient is defined as the worst case voltage change divided by the total temperature range

Note 2: Dropout voltage is defined as the input to output differential at which the output voltage drops 100mV below its nominal value measured at 1V differential at very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

Note 3: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied. excluding load or line regulation effect.

TYPICAL PERFORMANCE CHARACTERISTICS

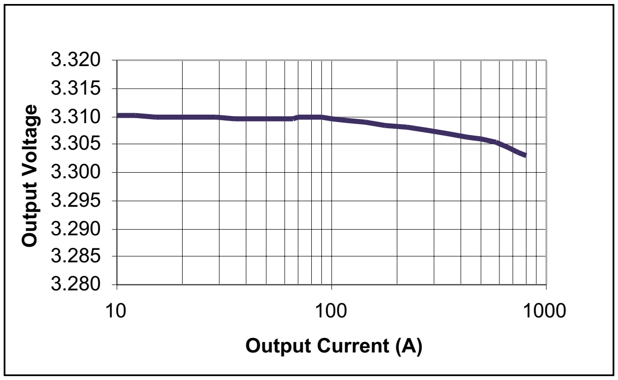


Figure 1. Load Regulation for SPX1117M3-3.3; V_{IN}=4.8V, C_{OUT}=2.2µF

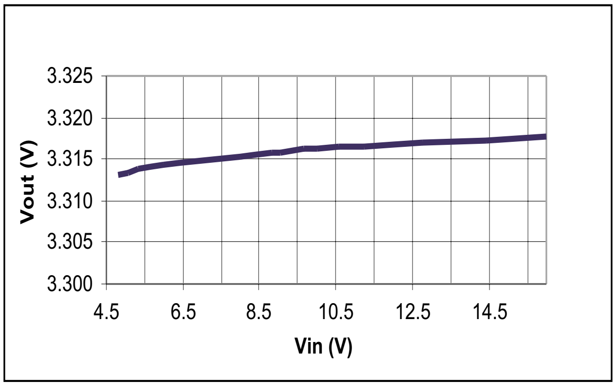


Figure 2. Line Regulation for SPX1117M3-3.3; V_{IN}=4.8V, C_{OUT}=2.2µF

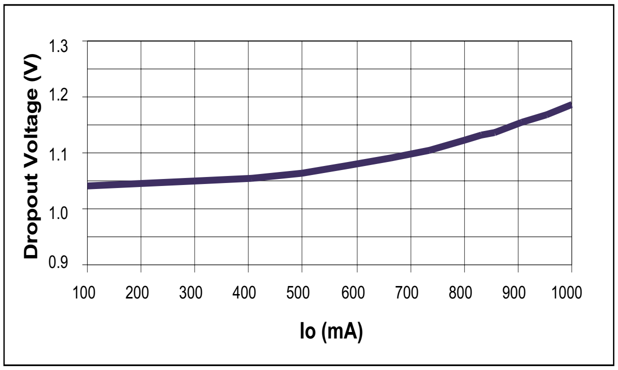


Figure 3. Dropout Voltage vs Output Current for SPX1117M3-3.3; V_{IN}=4.8V, C_{OUT}=2.2µF

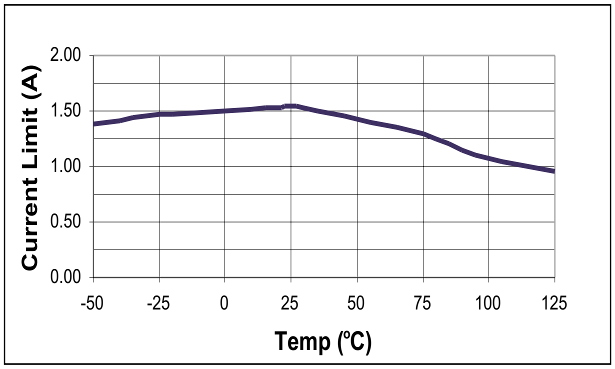


Figure 4. Current Limit for SP1117M3-3.3; V_{IN}=4.8V, C_{IN}=C_{OUT}=1µF, I_{OUT} pulsed from 10mA to Current Limit

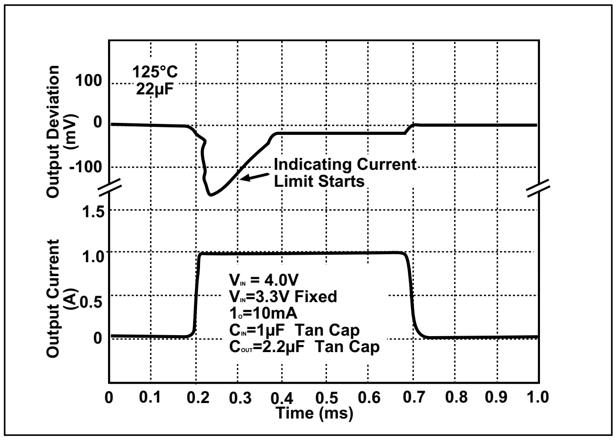


Figure 5. Current Limit for SPX1117M3-3.3, Output Voltage Deviation with I_{OUT}=10mA to 1A Step.

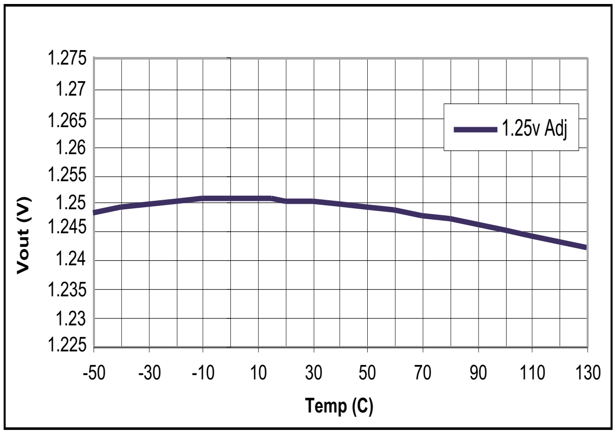


Figure 6. V_{OUT} vs Temperature, V_{IN}=2.5V, I_{OUT}=10mA

TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

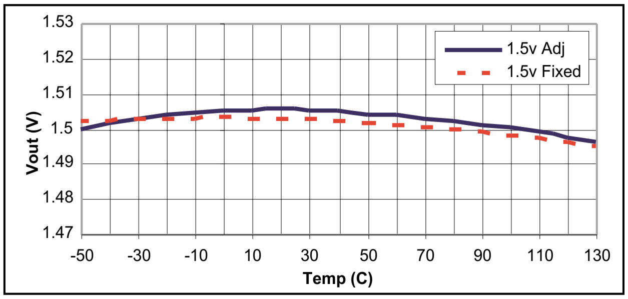


Figure 7. V_{IN}***=3.0V,*** I_{OUT}***=10mA***

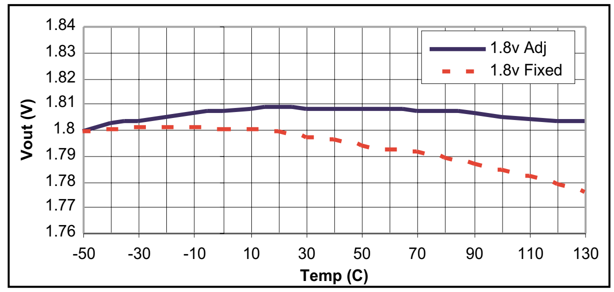


Figure 8. V_{IN}***=3.3V,*** I_{OUT}***=10mA***

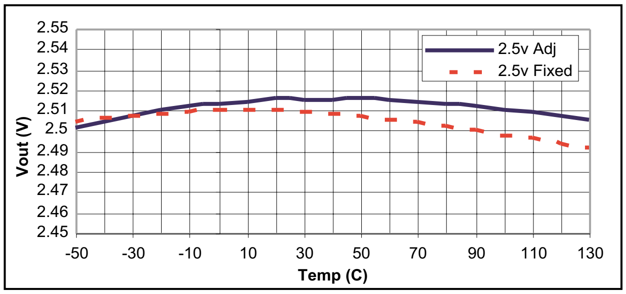


Figure 9. V_{IN}***=4.0V,*** I_{OUT}***=10mA***

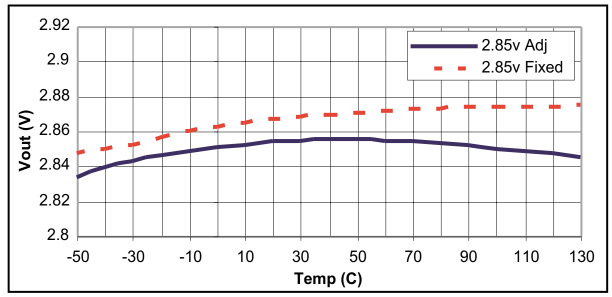


Figure 10. V_{IN}***=4.85V,*** I_{OUT}***=10mA***

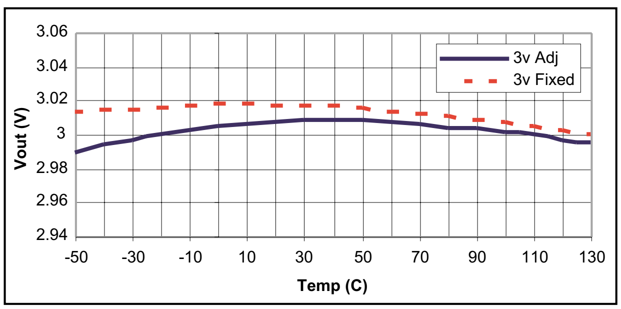


Figure 11. V_{IN}***=4.85V,*** I_{OUT}***=10mA***

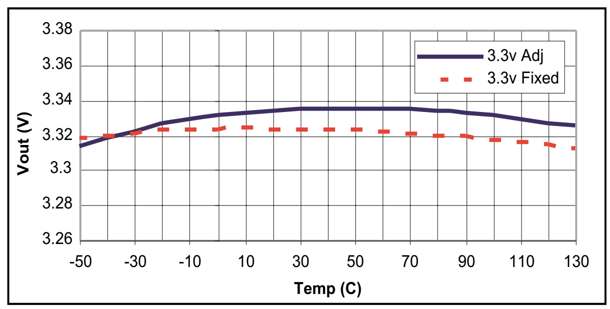


Figure 12. V_{IN}***=5.0V,*** I_{OUT}***=10mA***

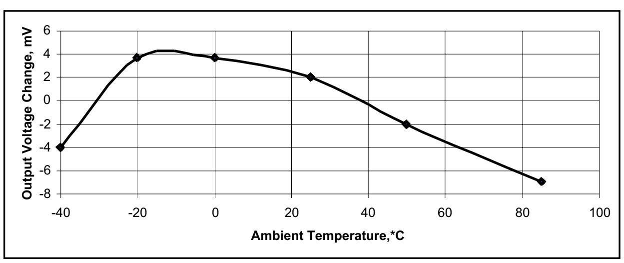


Figure 13. Line Regulation vs Temperature. Vout=1.8V (adjustable), Vin= 3.3V

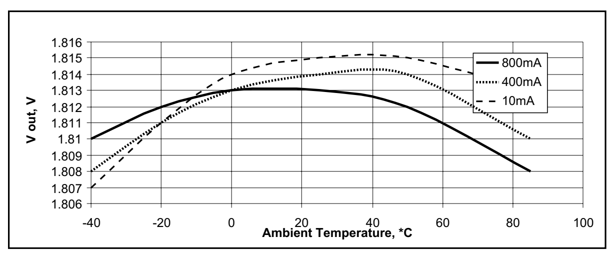


Figure 14. Output Voltage vs Temperature at different Current Loads, Vin=3.3V

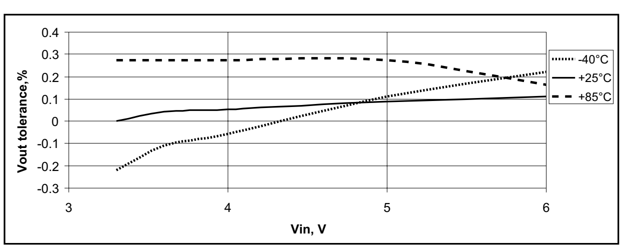


Figure 15. Line Regulation at Iload=800mA over Temperature, Vout=1.8V adjustable

Output Capacitor

To ensure the stability of the SPX1117, an output capacitor of at least 2.2µF (tantalum or ceramic) or 10µF (aluminum) is required. The value may change based on the application requirements of the output load or temperature range. The value of ESR can vary based on the type of capacitor used in the applications to guarantee stability. The recommended value for ESR is 0.5Ω or less. A larger value of output capacitance (up to 100µF) can improve the load transient response.

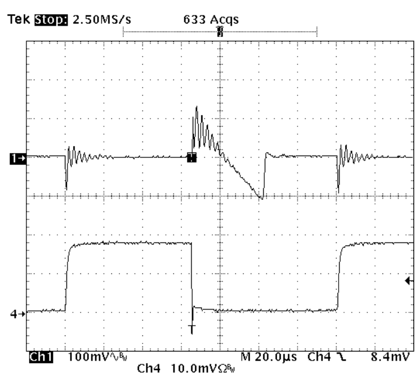


Figure 16. Load Step Response (0 to 800mA), Vin=3.3V, Vout=1.8V, Cin=10µF, Cout=2.2µF, Ceramic; 1 = Vout, 4= Iload

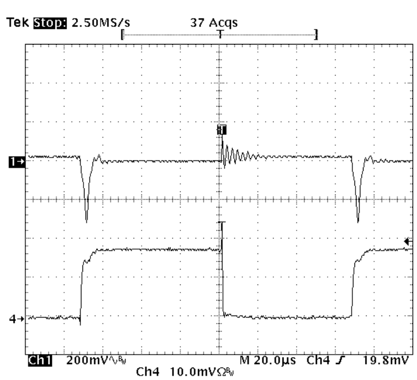


Figure 17. Load Step Response (0 to 800mA), Vin=3.3V, Vout=1.8V, Cin=10µF, Cout=2.2µF, OSCON; 1 = Vout, 4= Iload

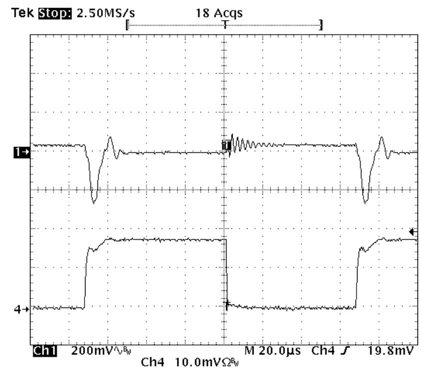


Figure 18. Load Step Response (0 to 800mA), Vin=3.3V, Vout=1.8V, Cout=10µF, OSCON; 1 = Vout, 4= Iload

Soldering Methods

The SPX1117 SOT-223 package is designed to be compatible with infrared reflow or vapor-phase reflow soldering techniques. During soldering, the non-active or mildly active fluxes may be used. The SPX1117 die is attached to the heatsink lead which exits opposite the input, output, and ground pins.

Hand soldering and wave soldering should be avoided since these methods can cause damage to the device with excessive thermal gradients on the package. The SOT-223 recommended soldering method are as follows: vapor phase reflow and infrared reflow with the component preheated to within 65°C of the soldering temperature range.

Thermal Characteristics

The thermal resistance of SPX1117 (SOT-223 Package) is 15°C/W from junction to tab and 31 °C/W from tab to ambient for a total of 46 °C/W from junction to ambient (Table 1). The SPX1117 features the internal thermal limiting to protect the device during overload conditions. Special care needs to be taken during continuous load conditions such that the maximum junction temperature does not exceed 125 °C. Thermal protection is activated at >144°C and deactiviated at <137 °C.

Taking the FR-4 printed circuit board and 1/16 thick with 1 ounce copper foil as an experiment (fig.13), the PCB material is effective at transmitting heat with the tab attached to the pad area and a ground plane layer on the backside of the substrate. Refer to table 1 for the results of the experiment.

The thermal interaction from other components in the application can effect the thermal resistance of the SPX1117. The actual thermal resistance can be determined with experimentation.

SPX1117 power dissipation is calculated as follows:

$$P_D = (V_{IN} - V_{OUT})(I_{OUT})$$

Maximum Junction Temperature range:

$$T_J = T_A(max) + P_D * \text{thermal resistance}$$

(junction-to-ambient)

Maximum junction temperature must not exceed the 125°C.

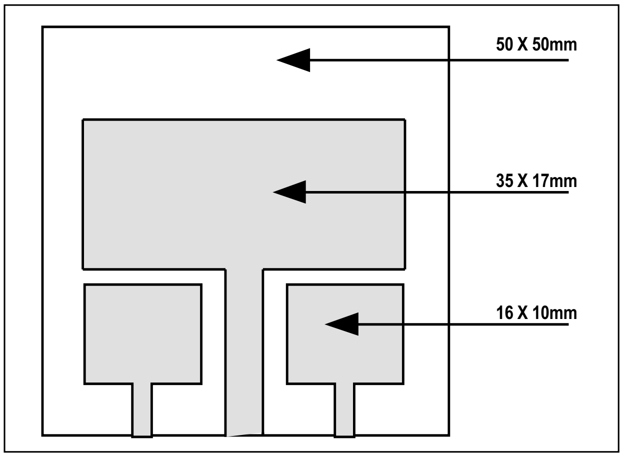


Figure 19. Substrate Layout for SOT-223

Ripple Rejection

Ripple rejection can be improved by adding a capacitor between the ADJ pin and ground as shown in Figure 23. When ADJ pin bypassing is used, the value of the output capacitor required increases to its maximum. If the ADJ pin is not bypassed, the value of the output capacitor can be lowered to 10µF for an electrolytic aluminum capacitor or 2.2µF for a solid tantalum capacitor (Fig 22).

However the value of the ADJ-bypass capacitor should be chosen with respect to the following equation:

$$C = 1 / (6.28 * F_R * R_1)$$

Where

C = value of the capacitor in Farads (select an equal or larger standard value),
F_R = ripple frequency in Hz,
R_1 = value of resistor R1 in Ohms.

If an ADJ-bypass capacitor is used, the amplitude of the output ripple will be independent of the output voltage. If an ADJ-bypass capacitor is not used, the output ripple will be proportional to the ratio of the output voltage to the reference
voltage:

$$M = V_{OUT} / V_{REF}$$

Where M = multiplier for the ripple seen when the ADJ pin is optimally bypassed.

$$V_{REF} = 1.25V$$

Ripple rejection for the adjustable version is shown in Figure 20.

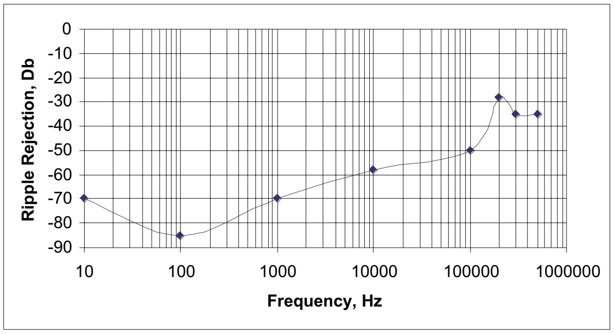


Figure 20. Ripple Rejection; Vin=3.3V, Vout=1.8V (adj.), Iload=200mA

TABLE 1

PC BOARD mm^2	TOPSIDE COPPER mm^2	BACKSIDE COPPER mm^2	THERMAL RESISTANCE JUNC. TO AMB. °C/W
2500	2500	2500	46
2500	1250	2500	47
2500	950	2500	49
2500	2500	0	51
2500	1800	0	53
1600	600	1600	55
2500	1250	0	58
2500	915	0	59
1600	600	0	67
900	240	900	72
900	240	0	85

Output Voltage

The output of the adjustable regulator can be set to any voltage between 1.25V and 15V. The value of V_{OUT} can be quickly approximated using the formula

$$V_{OUT}=1.25 *(R_1 + R_2)/R_1.$$

A small correction to this formula is required depending on the values of resistors R_1 and R_2, since the adjustable pin current (approx 50µA) flows through R_2. When I_{ADJ} is taken into account, the formula becomes

$$V_{OUT} = V_{REF}(1+ (R_2/R_1)) + I_{ADJ} * R_2,$$

where

$$V_{REF}=1.25V.$$

Layout Considerations

Parasitic line resistance can degrade load regulation. In order not to affect the behavior of the regulator, it is best to connect R_1 to the case as illustrated in Figure 25. For the same reason, R_2 should be connected to the negative side of the load.

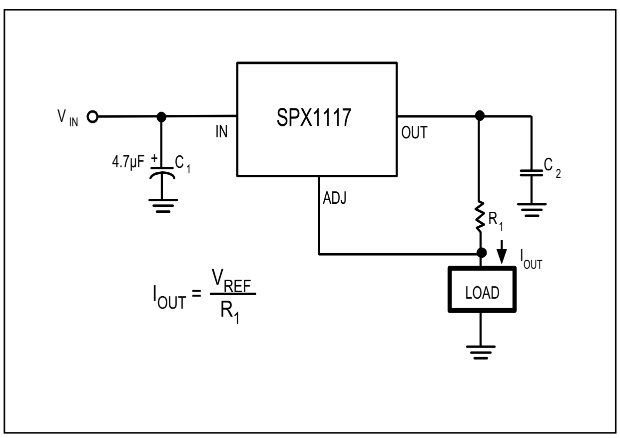


Figure 21. Current Source

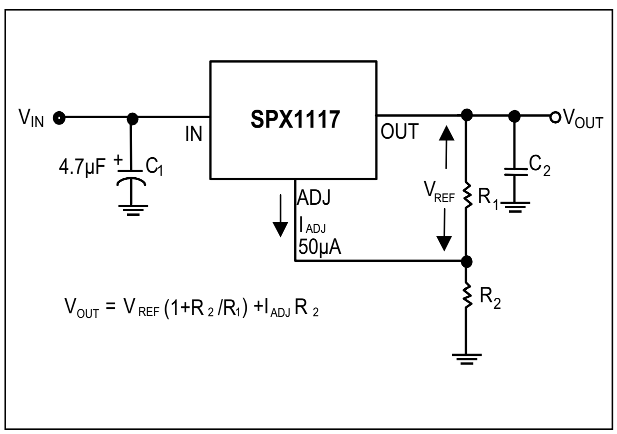


Figure 22. Typical Adjustable Regulator

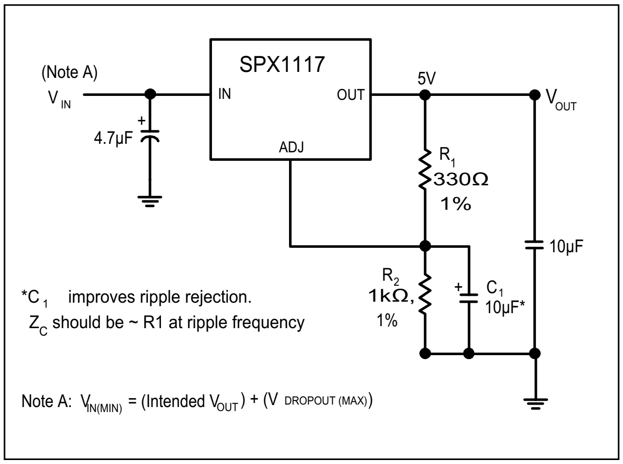


Figure 23. Improving Ripple Rejection

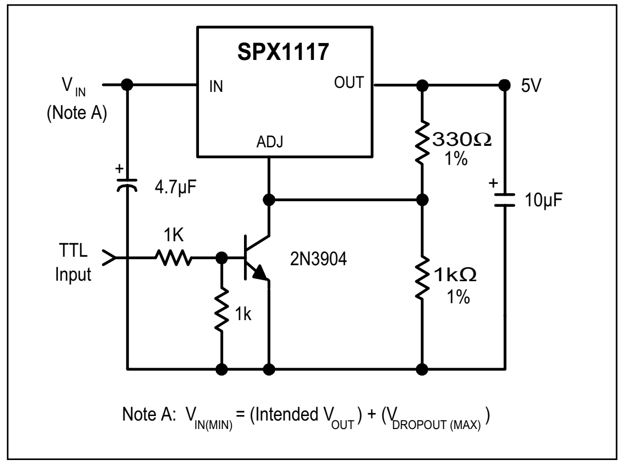


Figure 24. 5V Regulator with Shutdown

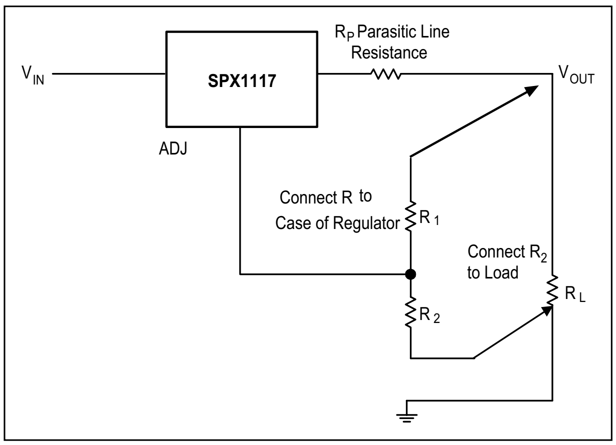
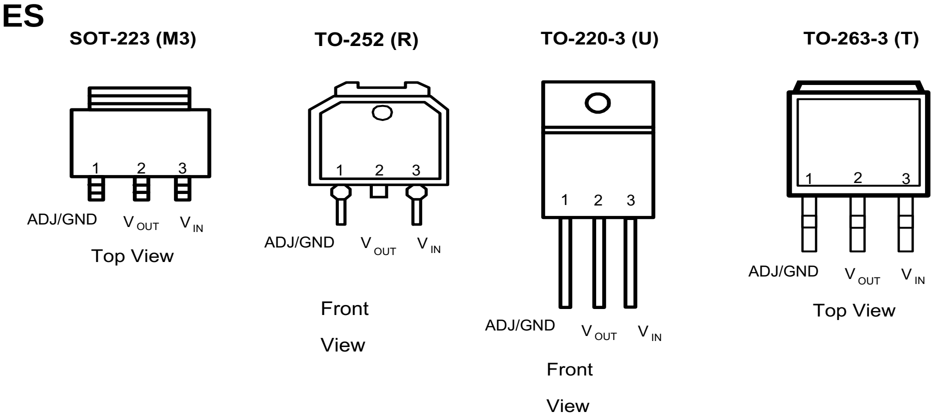


Figure 25. Recommended Connections for Best Results

PACKAGES



ORDERING INFORMATION

PART NUMBER	ACC.	OUTPUT VOLTAGE	PACKAGE
SPX1117U	1%	Adj	3 lead TO220
SPX1117U-1.5	1%	1.5V	3 lead TO220
SPX1117U-1.8	1%	1.8V	3 lead TO220
SPX1117U-2.5	1%	2.5V	3 lead TO220
SPX1117U-2.85	1%	2.85V	3 lead TO220
SPX1117U-3.0	1%	3.0V	3 lead TO220
SPX1117U-3.3	1%	3.3V	3 lead TO220
SPX1117T	1%	Adj	3 lead TO-263
SPX1117T-1.5	1%	1.5V	3 lead TO-263
SPX1117T-1.8	1%	1.8V	3 lead TO-263
SPX1117T-2.5	1%	2.5V	3 lead TO-263
SPX1117T-2.85	1%	2.85V	3 lead TO-263
SPX1117T-3.0	1%	3.0V	3 lead TO-263
SPX1117T-3.3	1%	3.3V	3 lead TO-263
SPX1117M3	1%	Adj	3 lead SOT-223
SPX1117M3-1.5	1%	1.5V	3 lead SOT-223
SPX1117M3-1.8	1%	1.8V	3 lead SOT-223
SPX1117M3-2.5	1%	2.5V	3 lead SOT-223
SPX1117M3-2.85	1%	2.85V	3 lead SOT-223
SPX1117M3-3.0	1%	3.0V	3 lead SOT-223
SPX1117M3-3.3	1%	3.3V	3 lead SOT-223
SPX1117R	1%	Adj	3 lead TO-252
SPX1117R-1.5	1%	1.5V	3 lead TO-252
SPX1117R-1.8	1%	1.8V	3 lead TO-252
SPX1117R-2.5	1%	2.5V	3 lead TO-252
SPX1117R-2.85	1%	2.85V	3 lead TO-252
SPX1117R-3.0	1%	3.0V	3 lead TO-252
SPX1117R-3.3	1%	3.3V	3 lead TO-252

Please consult the factory for pricing and availability on a Tape-On-Reel option.

SIGNAL PROCESSING EXCELLENCE

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